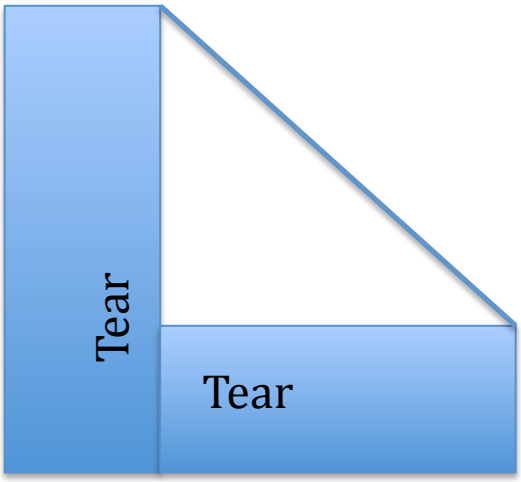
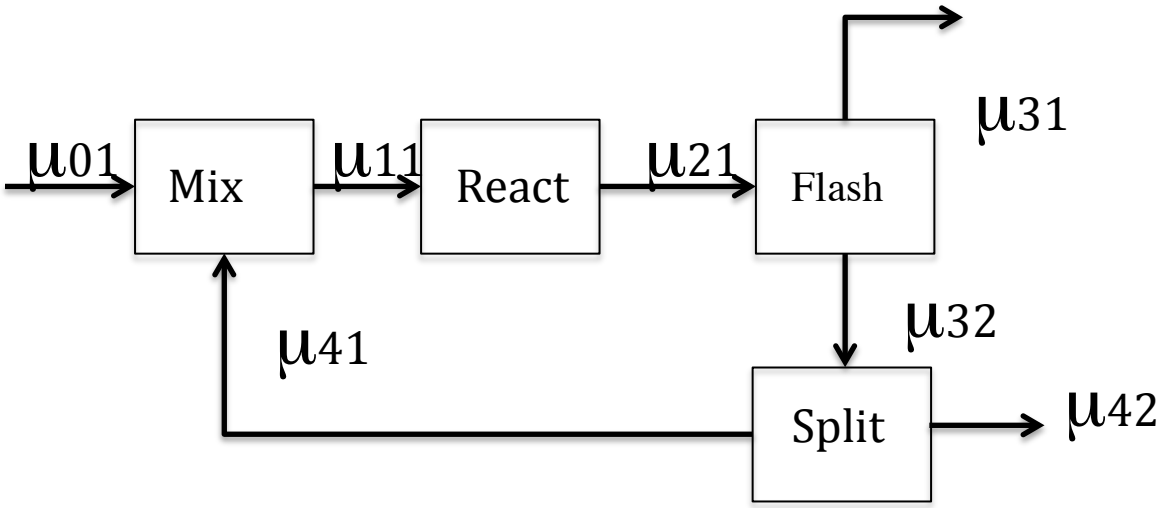
Poor Man's Tearing Algorithm

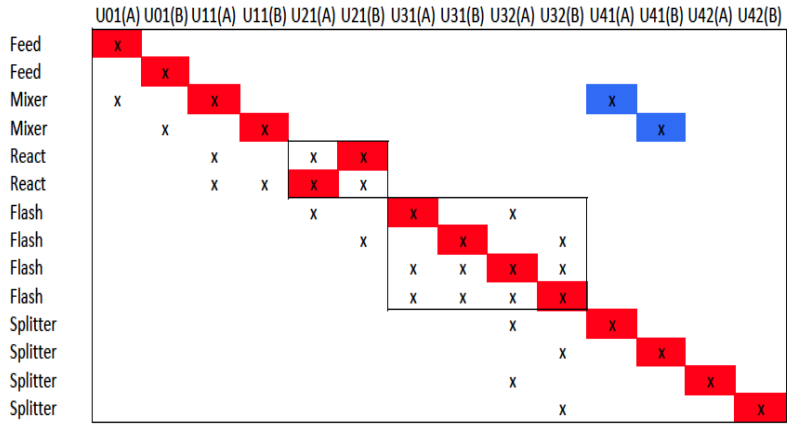
1. Identify an open column with the fewest number of incidences (variables).
2. In that column, find the row with the fewest open incidences.
3. Delete the row and column. If there are any open columns, go to step 1.
4. We now have an output set (assignment of variables to equations). Permute this system to a bordered lower triangular structure. The left column block represents the tear variables, the bottom row block represents tear equations and the lower triangular form represents variables and equations that can be solved in sequence.



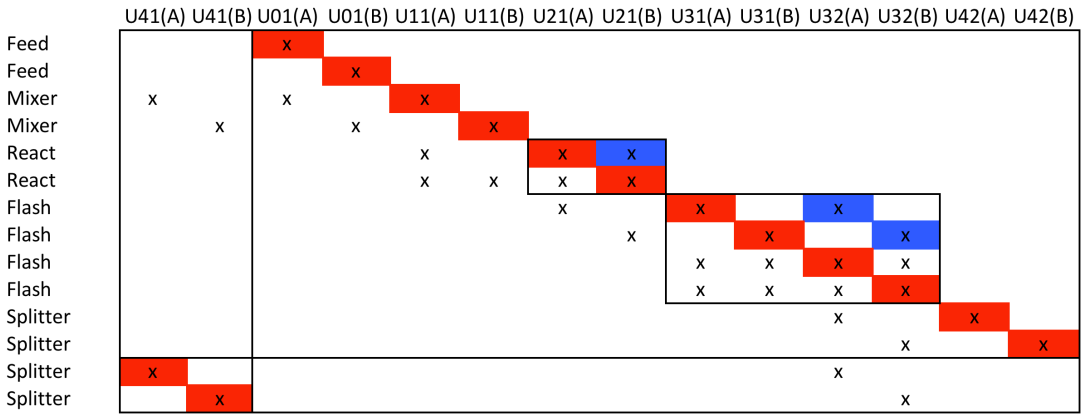
Consider the flowsheet given below with the equations given in class.



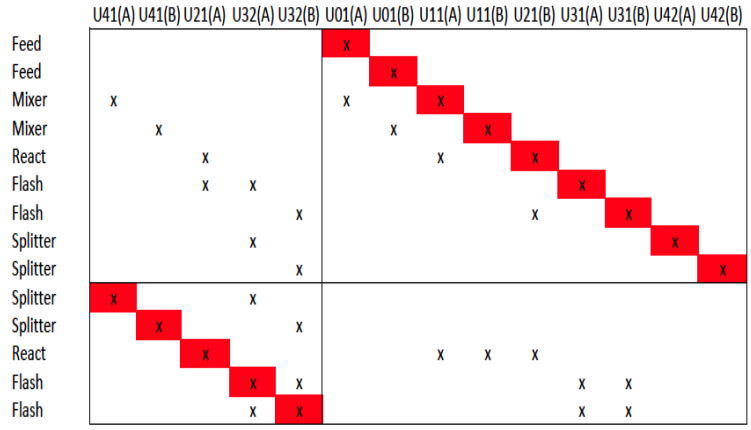
To decompose this flowsheet we will use the “poor man’s” tearing algorithm on the flowsheet’s incidence matrix in order to find the output set (red blocks).



Note that the react and flash modules require iteration as sets of equations. The blue elements represent spikes that involve the flowsheet recycle or tear variables μ_{41}(A) and μ_{41}(B). Arranging the incidence to bordered block lower triangular form, gives the incidence matrix below. Also, in the left bottom block we see the output set for the tear stream. In this system, we follow the same calculation sequence as with the modular approach. In this case, the module equations remain intact and are calculated together. Moreover, the blue elements in the react and flash modules represent the spikes that require iteration.



Using the above spikes and perturbing the matrix to bordered lower triangular form leads to the following system.



Notice that the number of tear variables (and tear equations) has increased from two to five. Also, the modules equations have now been broken up and the tear equations are now taken from the split, flash and react modules. Moreover, in the left bottom block we see the output set for the tear variables. For the lower triangular system, the equations (not the modules) are now solved in sequence.

Questions to think about:

1. How do we solve the system with 5 tear variables and tear equations? What numerical algorithm do we use?

2. Which system is easier to solve?
   - Modular with two tear variables and equations
   - Decomposed system with five tear variables and equations
   - Simultaneous system with 14 variables and equations